MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2017/2018

EEE 7236 – POWER ELECTRONICS AND ELECTRICAL MACHINES

15 MARCH 2018
8.00 p.m – 11.00 p.m
(3 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 5 pages including cover page with 4 Questions only.
2. Answer ALL questions. The distributions of the marks for each question are as stated.
3. Please write all your answers in the Answer Booklet provided.

Question 1

a) Power electronic converter provides control over power to be supplied to the loads. When designing a power electronic converter, it is crucial to select the right components. Explain the THREE factors which you will consider in performing the selection. [6 marks]

b) Under the transistor family of semiconductor devices, BJT, MOSFET and IGBT are among the more common ones in power electronic converter applications. Table 1(b) to compare the performance and characteristics of the 3 devices. Assume that the semiconductor devices are of similar size and ratings. [8 marks]

Table 1(b)

Features	BJT	MOSFET	IGBT
Drive method			
Drive circuit			
Input impedance			
Drive power			
Switching speed			
Operating frequency			
SOA			
Saturation voltage			

c) Calculate the total average power losses of the BJT circuit shown in Figure 1(c)(i). The parameters of the corresponding switching waveform in Figure 1(c)(ii) are:

i. $V_{CC} = 200V$
ii. $V_{BE(sat)} = 2.5V$
iii. $I_B = 10A$
iv. $V_{CE(sat)} = 1V$
v. $I_{CS} = 200$ A
vi. $t_d = 1$ μs
vii. $t_r = 2$ μs
viii. $t_s = 4$ μs
ix. $t_f = 5$ μs
x. $f_s = 10$ kHz
xi. duty cycle k = 50 %
xii. $I_{CEO} = 1$ mA [11 marks]

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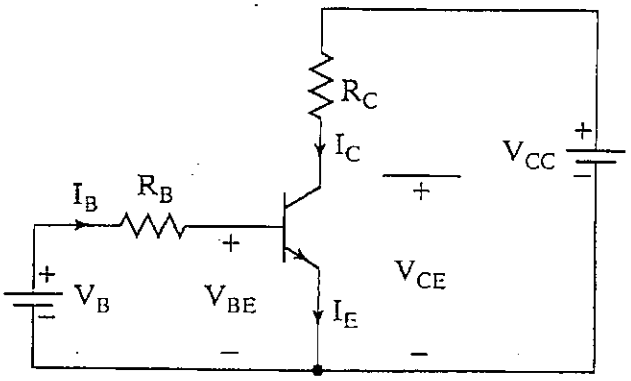

Figure 1(c)(i)

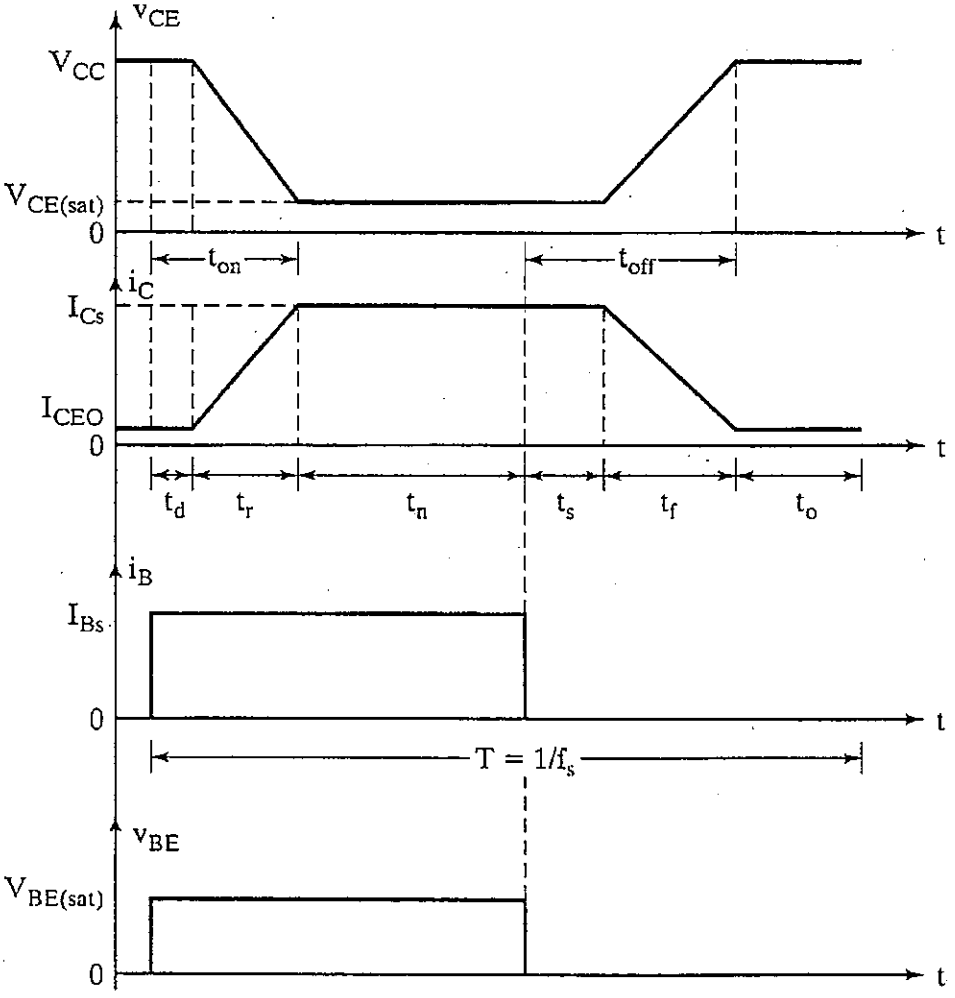

Figure 1(c)(ii)

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Question 2

(a) Compare linear power supplies with switched-mode power supplies. [6 marks]

(b) Design a Buck converter which can produce average output voltage of 8V with peak-to-peak output ripple voltage of 15mV. The inductor current and capacitor voltage must both be continuous. You are given the option of selecting any of these batteries which can supply 6V, 10V and 12V respectively. The switching frequency is 50kHz. You are also given a resistor of 1kΩ and is required to limit the peak-to-peak inductor current to 0.5A. In your design, clearly illustrate the circuit required with all the necessary components. [12 marks]

(c) With the aid of a circuit, explain how Buck-Boost converter operates. Briefly explain the two modes of operations and the nature of the output voltage. [7 marks]

Question 3

(a) A 4-pole 80kW, 800V, lap wound DC generator has 60 coils each having 12 turns. The flux per pole is 20mWb.The speed is 1800 rpm. Calculate the induced voltage. If it is shunt connected and the field winding resistance is 160 Ω, draw its equivalent circuit and calculate its field current. [8 marks]

(b) A DC shunt motor operates on a 240V DC supply and draws a line current of 80A while running at a speed of 1500rpm. The armature resistance is 0.1Ω and the field resistance is 240Ω. Determine the external resistance to be added in series with the field circuit to increase the speed to 2500rpm. Assume the flux is linearly proportional to the field current and the armature current increases by 20%. [10 marks]

(c) Explain the purpose of a Single Phase Sychros Machine. Sketch a simple application circuit of a Single Phase Sychros Machine and explain its working principle. [7 marks]

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Question 4

(a) A three-phase synchronous generator with a line voltage of 20kV is connected to a power grid. It delivers 14 MW and 7 MVAR (inductive) to the grid. If it has a synchronous reactance of 3.5Ω/phase its armature resistance is negligible, determine:

i. the power factor angle
ii. the emf generated
iii. the power angle

[10 marks]

(b) A 2-phase, 1 pole paired rotor stepper motor is controlled using an uni-polar PLC control driver. Draw the cross section of the stepper motor indicating the poles. Sketch the required stepper motor input signals timing diagram showing step size versus number of poles for full 360° turn for below modes:

i. Full stepping drive
ii. Half stepping drive
iii. Also calculate the steeping interval (θ_m) and number of position required for both modes (i) and (ii).

[7 marks]

(c) A 4-pole, 3 phase 50Hz Y-connected induction motor runs at a speed of 1470 rpm at no load and at a speed of 1400 rpm at full load. Calculate the electrical frequency of rotor current at standstill, no load and full load conditions and the speed regulation of this motor.

[8 marks]

End of Paper